# Coupling Existing Software Paradigms for Thermal Control System Analysis of Re-Entry Vehicles, Phase I

Completed Technology Project (2015 - 2015)

## Project Introduction

The innovation proposed is the unification of existing and operational high fidelity simulation software tools into an integrated framework with which to predict aero-heating, ablation, thermal response, and structural integrity for re-entry vehicles (RV) under a full range of trajectory conditions from rarefied to continuum. Virtually all software components necessary to achieve this goal are available within the CRAFT Tech suite of simulation tools which have a range of modern day capabilities and features. Many of the capabilities have already been directly applied to reentry flows, such as ablation and regression modeling, transition to turbulence modeling, advanced chemistry and ionization modeling, non-local thermodynamic equilibrium modeling, and a hybrid coupled continuum-rarefied simulation framework for steady and unsteady flows. Other features, such as aero/thermo/structural coupling, also exist but have not been directly applied to reentry type flows so the Phase I effort will demonstrate them in both the rarefied and continuum regimes. Our hybrid continuum-rarefied framework presently contains only information exchange from continuum to rarefied regions. For reentry applications, especially for non-traditionally shaped vehicles, this assumption is no longer valid, so a proposed developmental task will implement a rarefied to continuum information exchange within our existing hybrid continuum-rarefied solver framework. Finally, a plan of action for the Phase II effort will be elaborated to define a common Application Program Interface to couple the various existing components, including software packages outside the CRAFT Tech toolset, into a single unified framework.

## Primary U.S. Work Locations and Key Partners
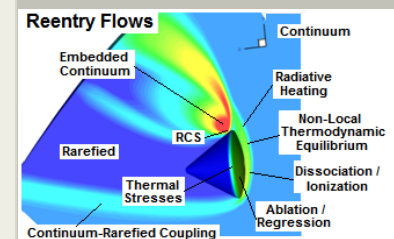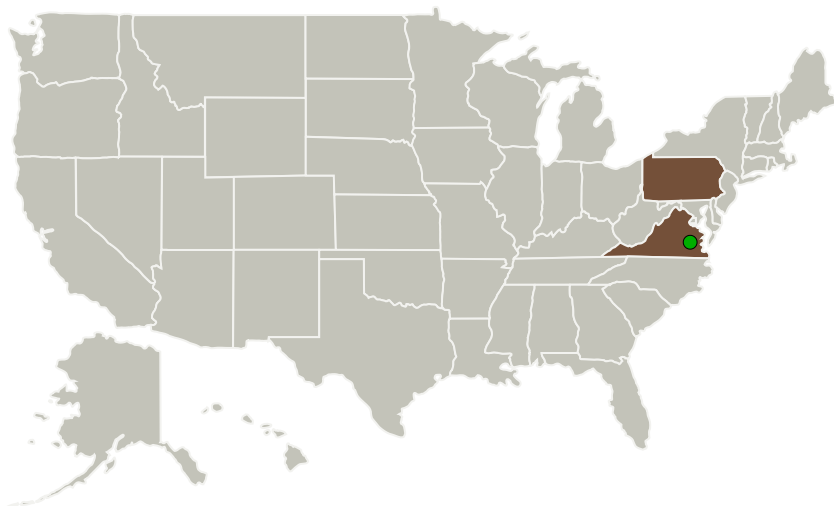
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## Table of Contents

| Organizations Performing Work | Role | Type | Location |
|---|---|---|---|
| CRAFT Tech - Combustion Research and Flow Technology | Lead Organization | Industry | Pipersville, Pennsylvania |
| 🟢Langley Research Center(LaRC) | Supporting Organization | NASA Center | Hampton, Virginia |

| Primary U.S. Work Locations | |
|---|---|
| Pennsylvania | Virginia |

## Project Transitions

▶ **June 2015:** Project Start

✅ **December 2015:** Closed out

**Closeout Summary:** Coupling Existing Software Paradigms for Thermal Control System Analysis of Re-Entry Vehicles, Phase I Project Image Coupling Existing Software Paradigms for Thermal Control System Analysis of Re-Entry Vehicles, Phase I

**Closeout Documentation:**
- Final Summary Chart Image*(https://techport.nasa.gov/file/138902)*

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Organization:**

CRAFT Tech - Combustion Research and Flow Technology

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

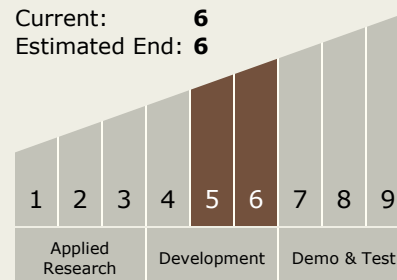**Program Director:**

Jason L Kessler

**Program Manager:**

Carlos Torrez

**Principal Investigator:**

John L Papp

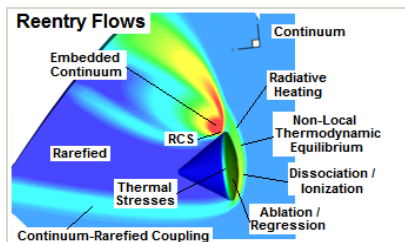## Technology Maturity (TRL)

Start: **5**
Current: **6**
Estimated End: **6**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| Applied Research | | | Development | | | Demo & Test | | |

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## Images



**Briefing Chart Image**
Coupling Existing Software Paradigms for Thermal Control System Analysis of Re-Entry Vehicles, Phase I
*(https://techport.nasa.gov/image/129303)*

## Technology Areas

**Primary:**

- TX14 Thermal Management Systems
  └ TX14.3 Thermal Protection Components and Systems
    └ TX14.3.3 Thermal Protection Analysis

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System